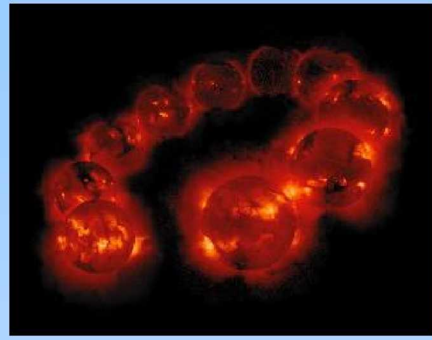
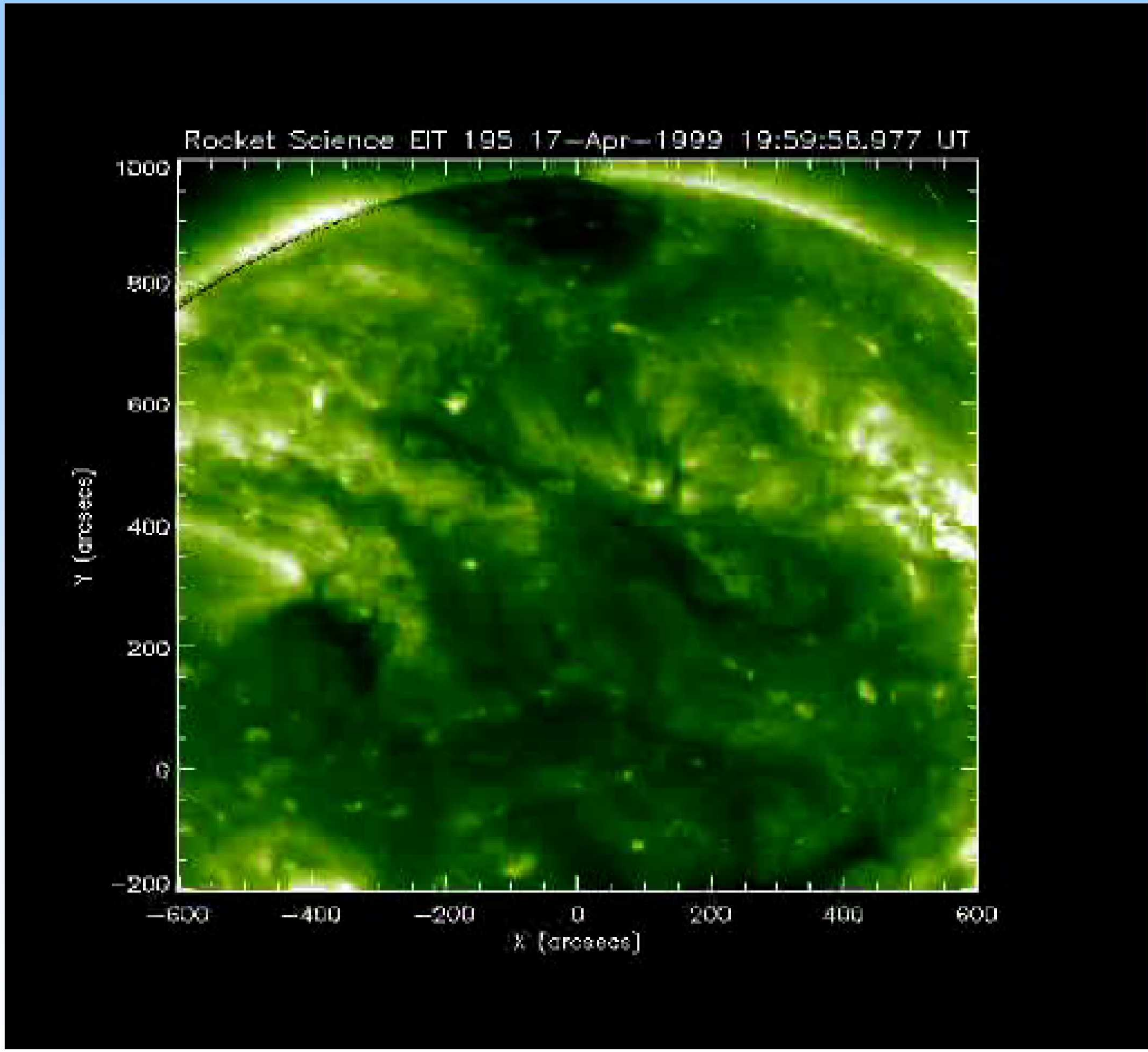
Filaments From L5

Alphonse C. Sterling
NASA/MSFC/NSSTC/JAXA/ISAS

Introduction

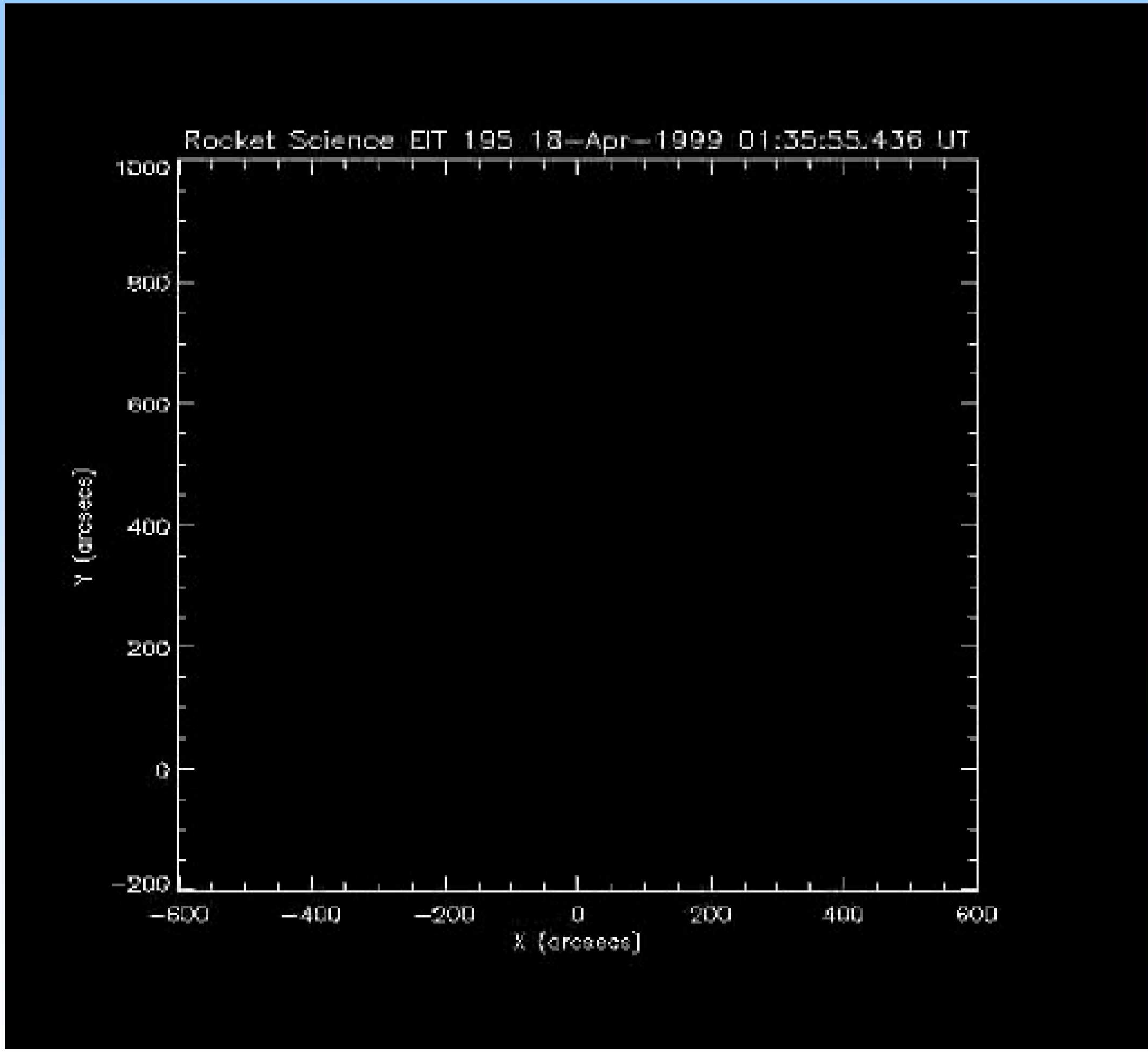


- We've been investigating filament eruptions in recent years (Sterling, Moore, et al.).
- Why do eruptions occur? Basic mechanism is magnetic, and can often include coronal mass ejections (CMEs), flares, and filament eruptions.
- Use *filament eruptions* as markers of the more-general eruption.
- From our studies, can identify directions for future work to help predict when eruptions might occur.

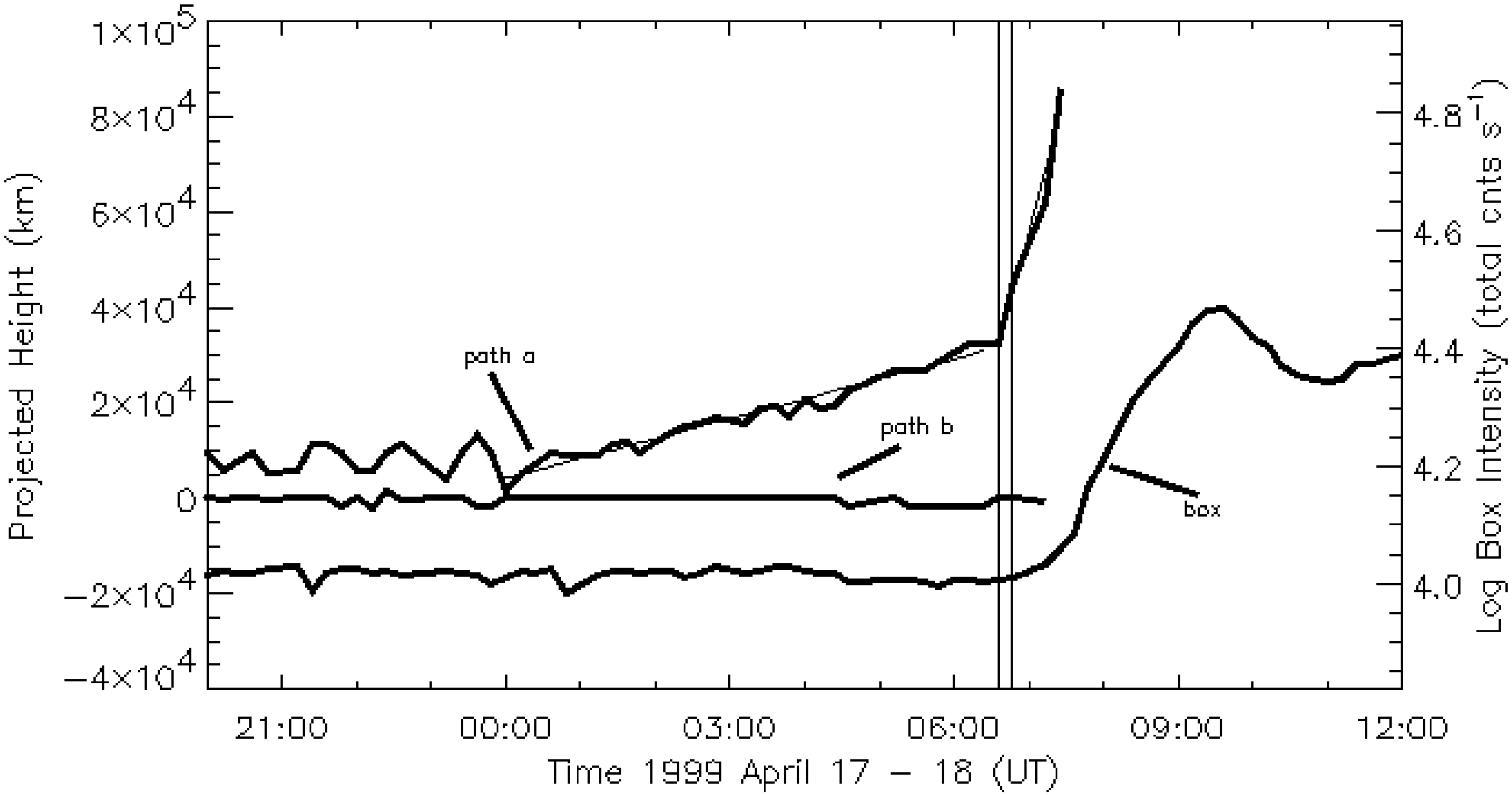


A. Sterling, April 2011
L5 Filaments

Sterling, Moore, & Thompson (2001)



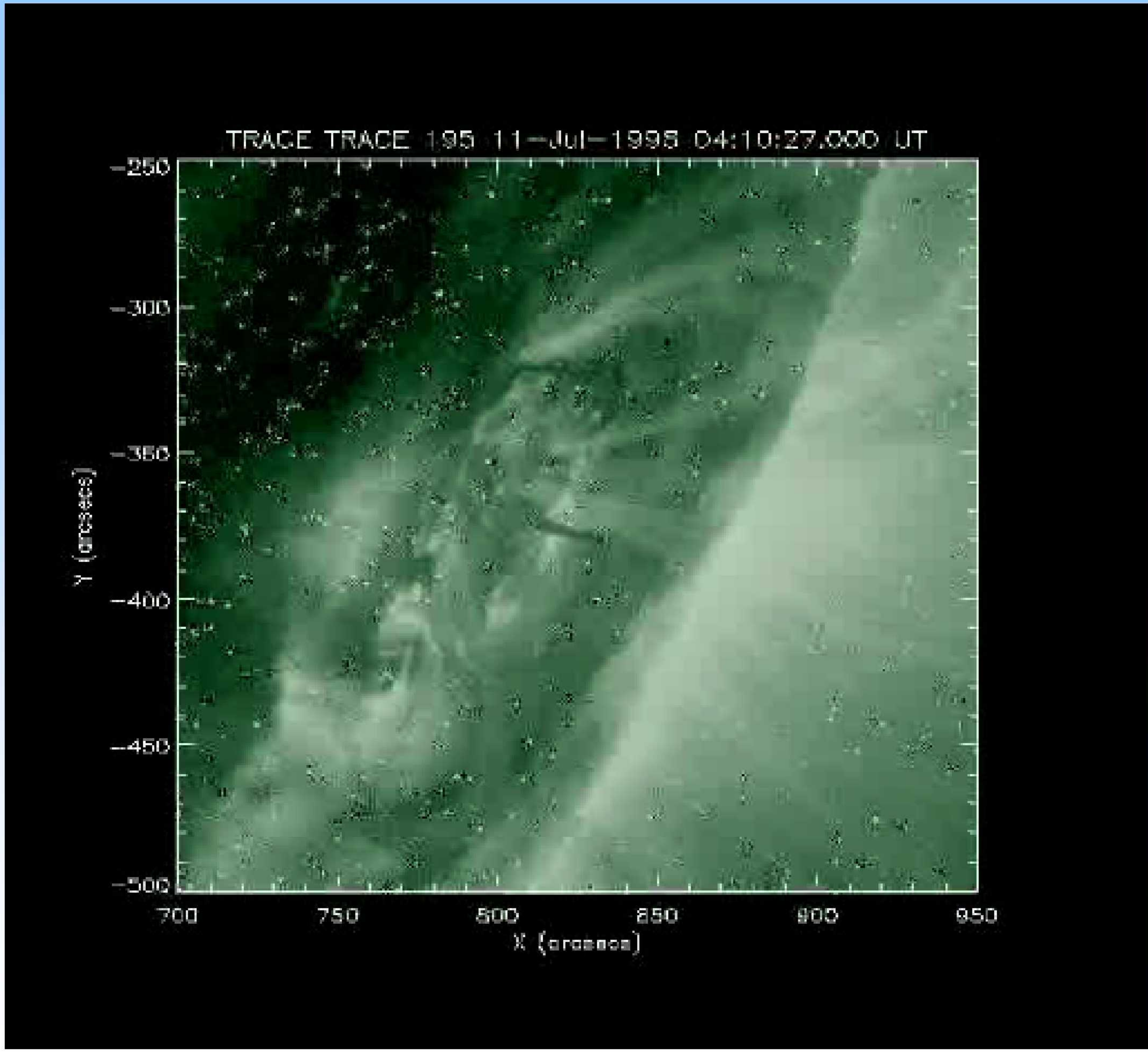
A. Sterling, April 2011
L5 Filaments



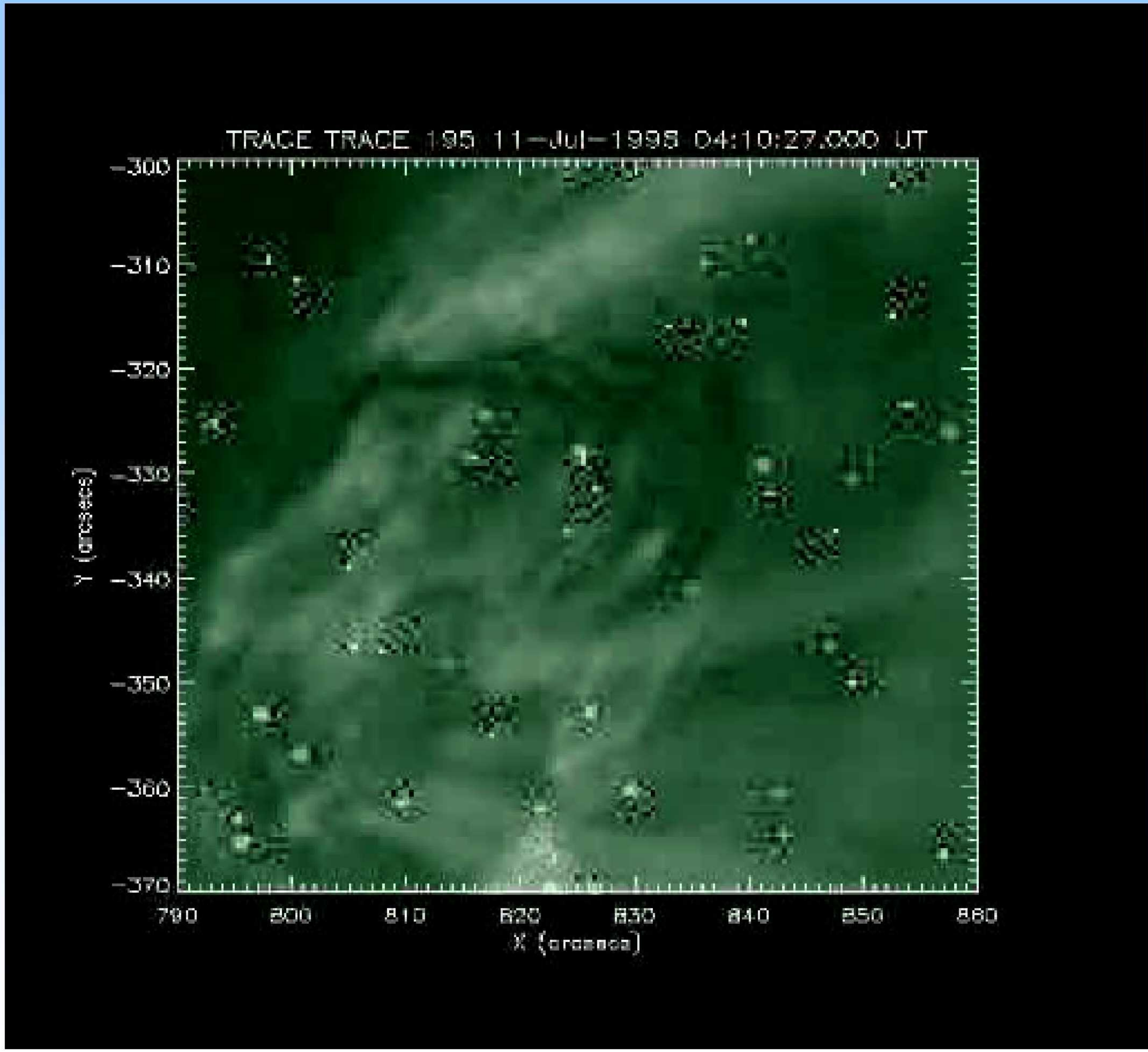
Sterling, Moore, Thompson (2001)

An AR-event example from TRACE

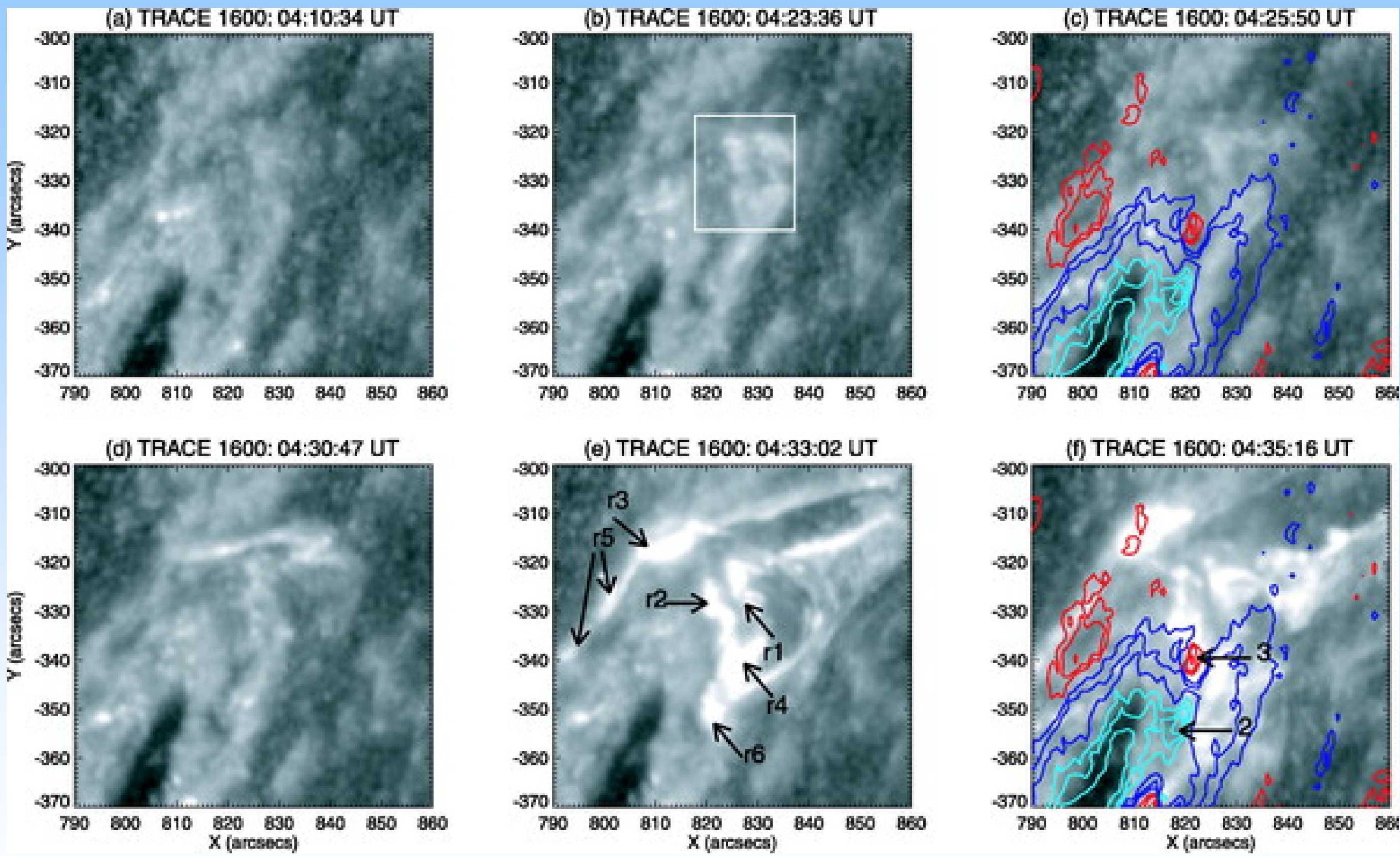
- Active Region Near-limb filament eruption of 11 July 1998.
- TRACE.
- Yohkoh SXT and HXT.
- SOHO/MDI magnetograms.
- Sterling & Moore (2005)



A. Sterling, April 2011
L5 Filaments



A. Sterling, April 2011
L5 Filaments

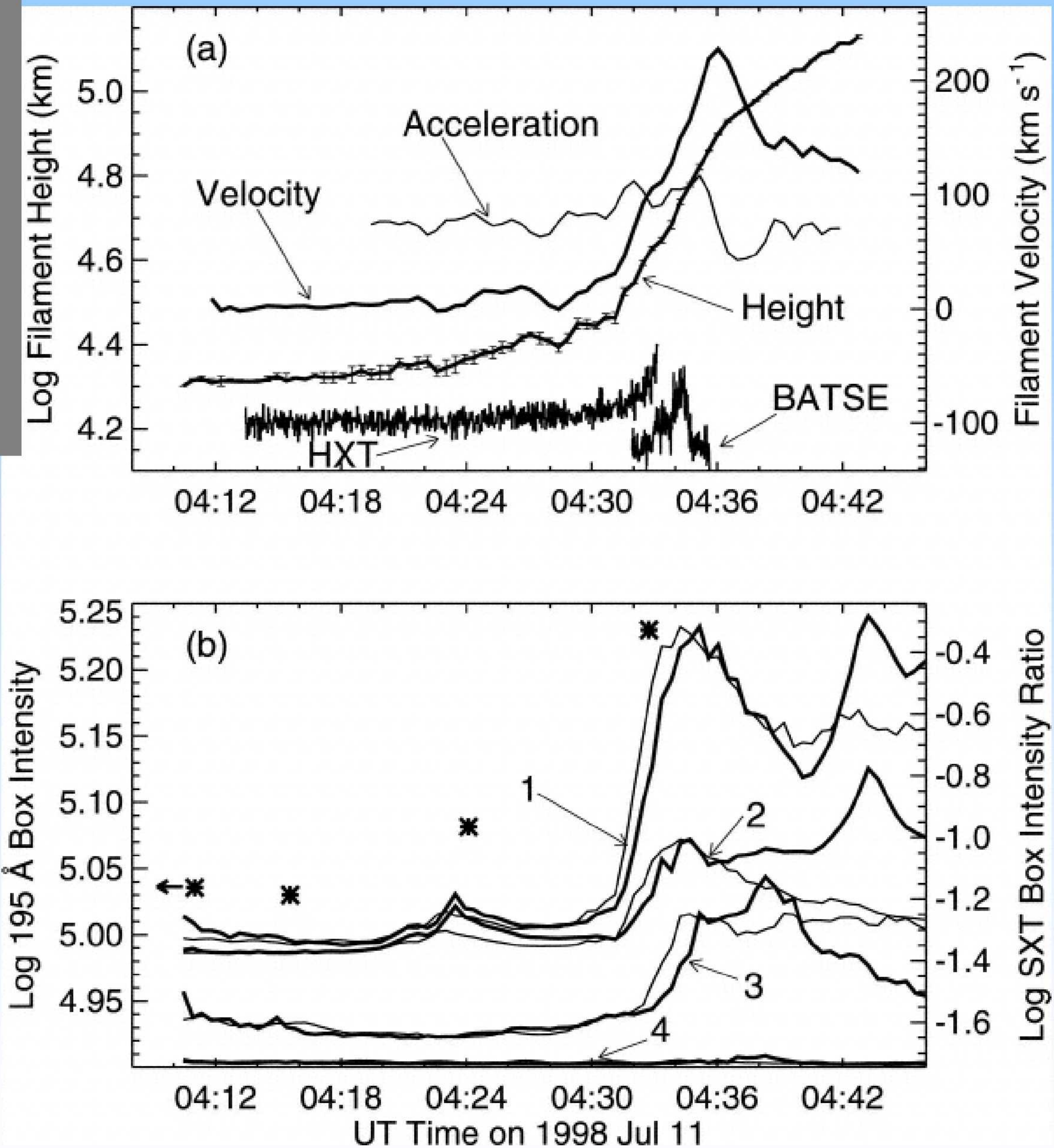


A. Sterling, April 2011
L5 Filaments

- Slow rise.

-Preflare brightening.

- AR event: Faster timescale than QR events.



A. Sterling, April 2011
L5 Filaments

Sterling & Moore (2005)

Some Questons, and Objectives

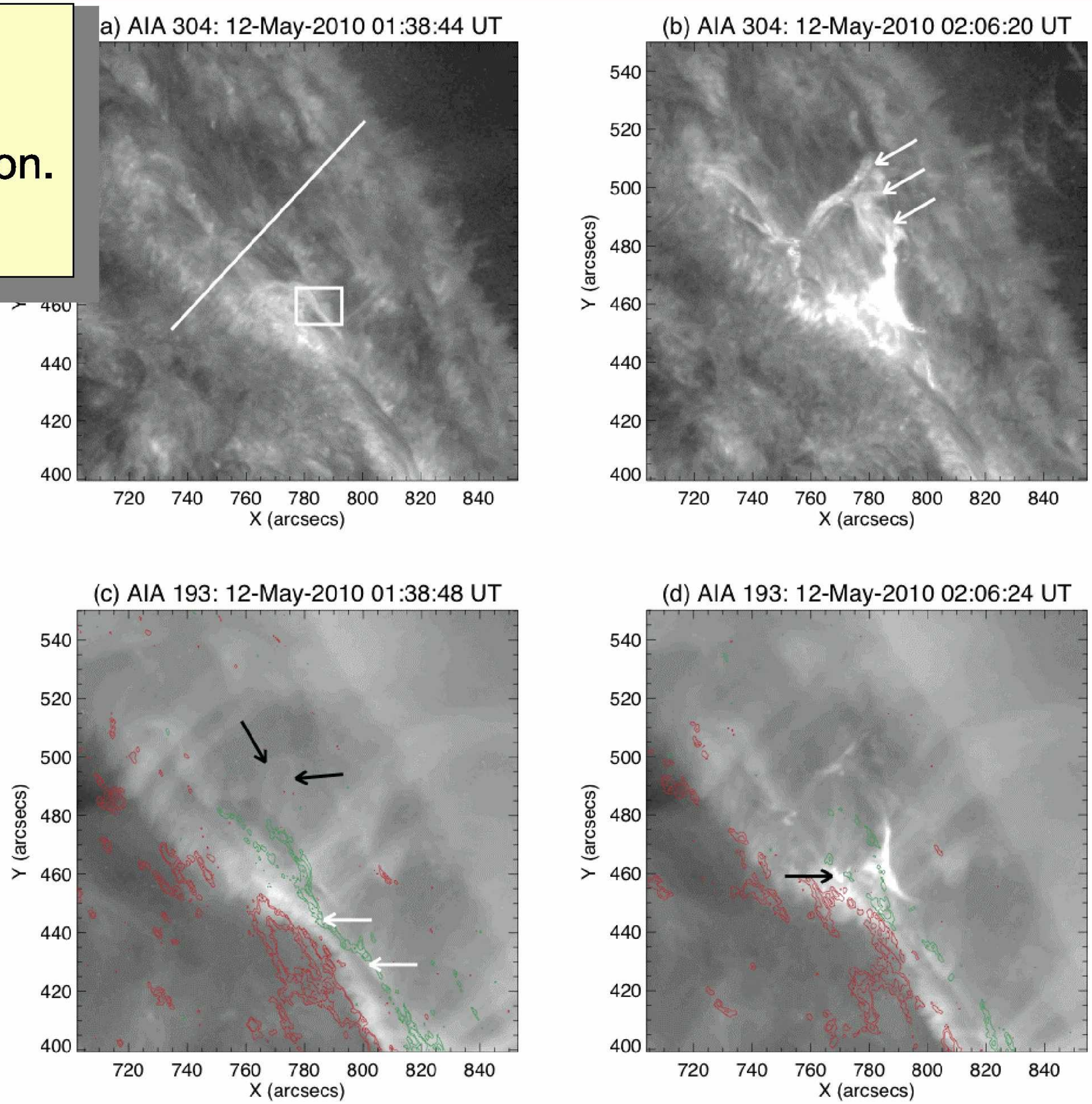
- How common is the slow-rise phase?
- What triggers the fast-rise phase? (TC, breakout, instability, something else?)
- What triggers the slow-rise phase? I suspect B cancelation and/or emergence.
- Examination of several more good events needed.
- More broadly:
  - Larger-scale consequences of slow rise phase (e.g., hints for breakout?).
  - Dimmings and remote connections (dittio).
- Need:
  - More good e.g.s (AR or QS).
  - B data.

An AR Confined ("Failed") Eruption from SDO

- Active Region Near-limb confined filament eruption of 12 May 2010.
- SDO/AIA, various filters.
- SDO/HMI, selected magnetograms.
- Sterling, Moore, & Freeland (2011).

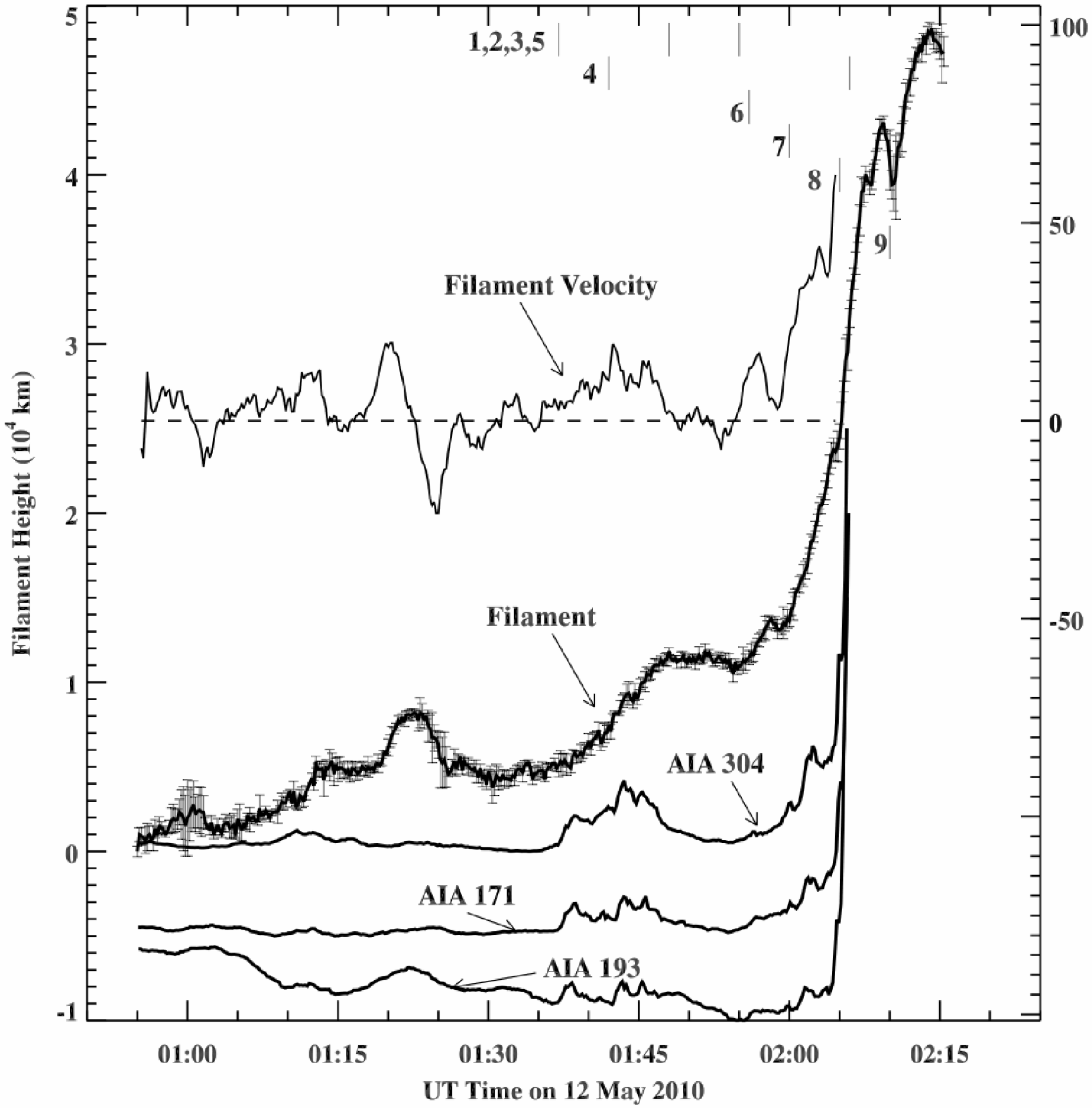
-Preflare brightening.

-B cancelation.

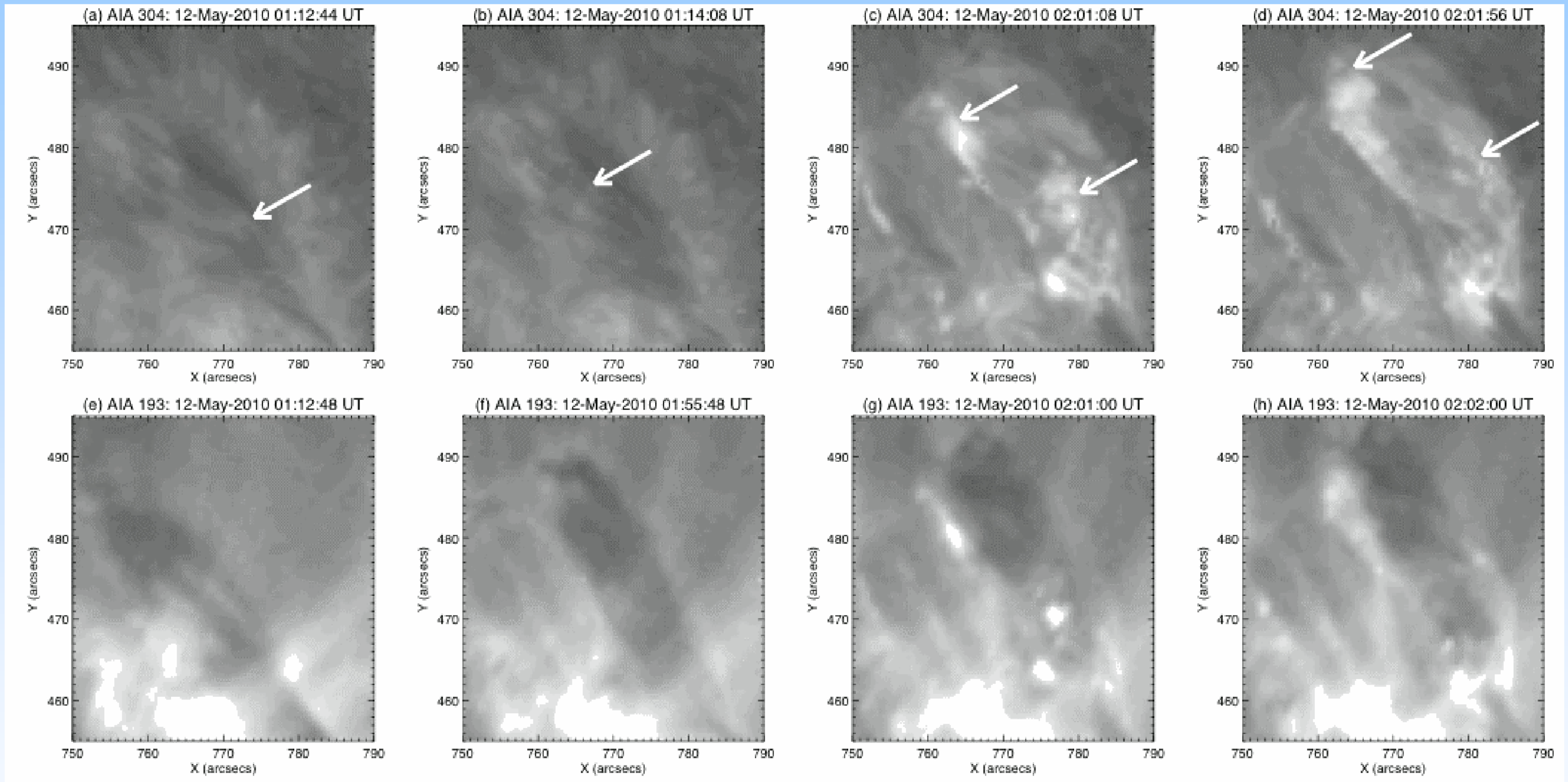


A. Sterling, April 2011 Sterling, Moore, & Freeland (2011)

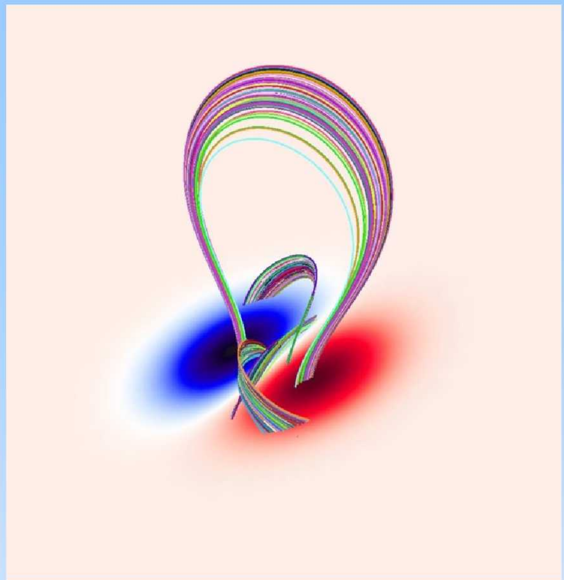
L5 Filaments

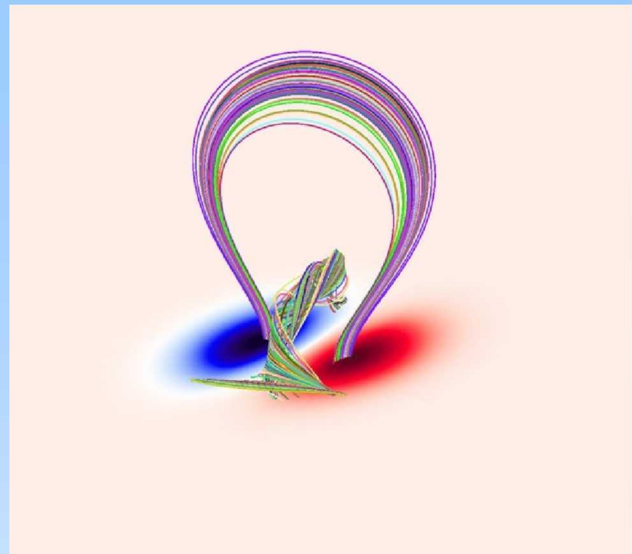


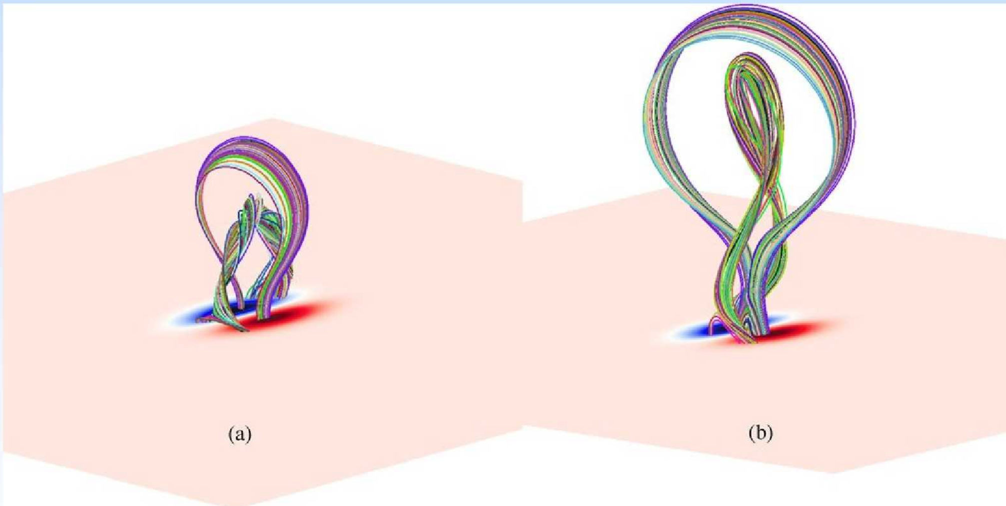
Sterling, Moore, & Freeland (2011)



A. Sterling, April 2011
L5 Filaments

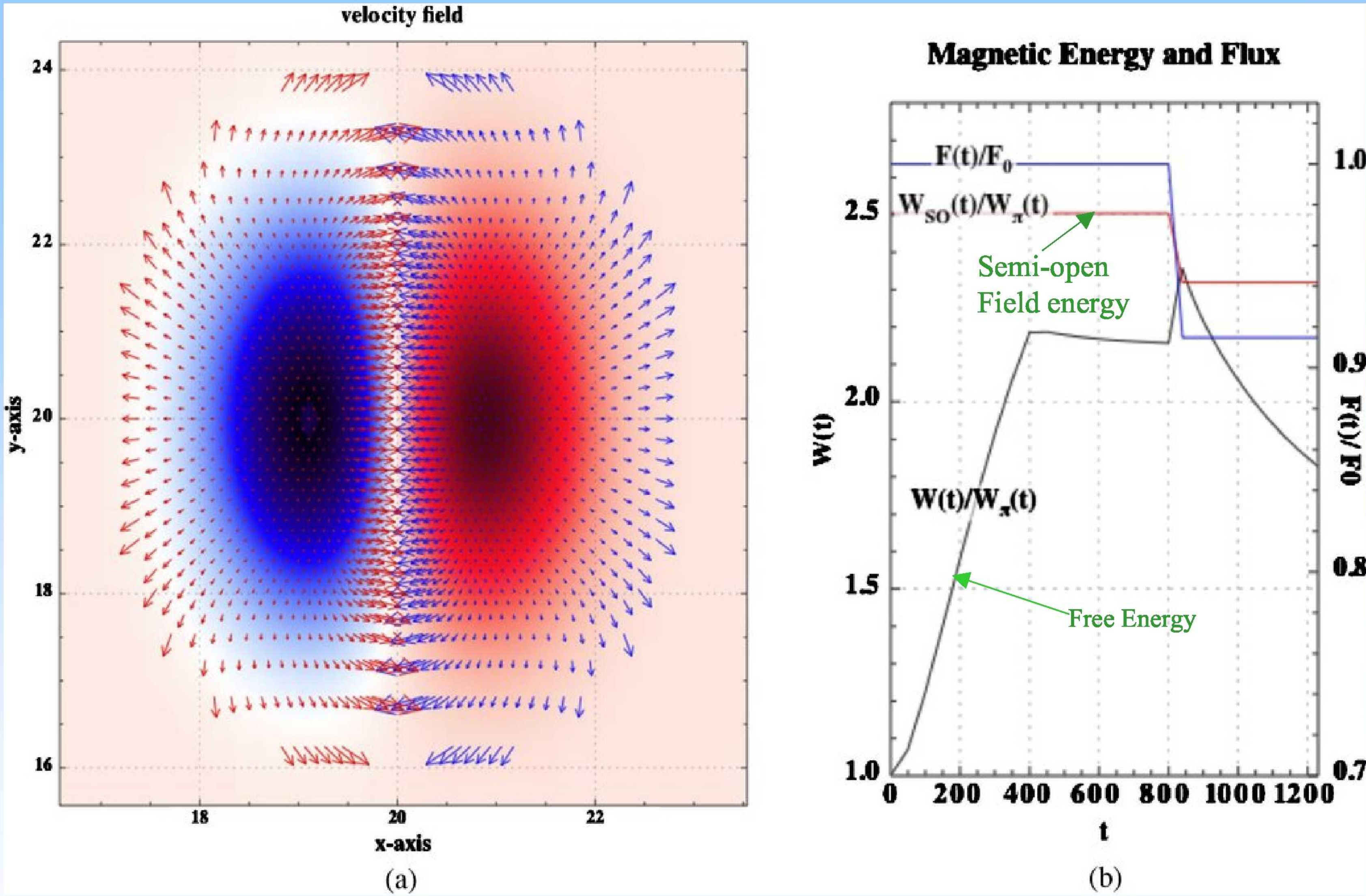






Amari et al. (2010) -- Flux Cancelation

A. Sterling, April 2011
L5 Filaments



Amari et al. (2010) -- Flux cancelation

A. Sterling, April 2011
L5 Filaments

Compare Amari et al and our SDO event

- We observe twisting or helical distortion from pre-flare brightening onset, so may have Amari et al.-type cancelation followed by kink instability:
- Amari et al. simulation: time from cancelation onset until eruption: ~ $38\tau_A$.
- SDO event:
  - L ~ 30,000 km
  - Guess: $v_A \sim 300$ km/s
    => $\tau_A = L/v_A \sim 100$ s; $38\tau_A \sim 60$ min.
  - Observed time from preflare brighteing to eruption ~ 20 min.
- So observations are comparable to simulations.

Summary

SDO Event: What We've Seen (Before)

- Converging (or emerging) fields
- Slow (unsteady) rise prior to eruption.
- Flare HXR burst begins when eruption fully underway.
- Preflare brightening, "affecting" filament trajectory.
- Pre-eruption filament "activation" (=slow rise phase?).
- EUV-brightening "cocoon" (aspect of fast phase).
- Twisting or distorting of filament field. Hints of timing of twist onset.

Summary

SDO Event: Some Questions

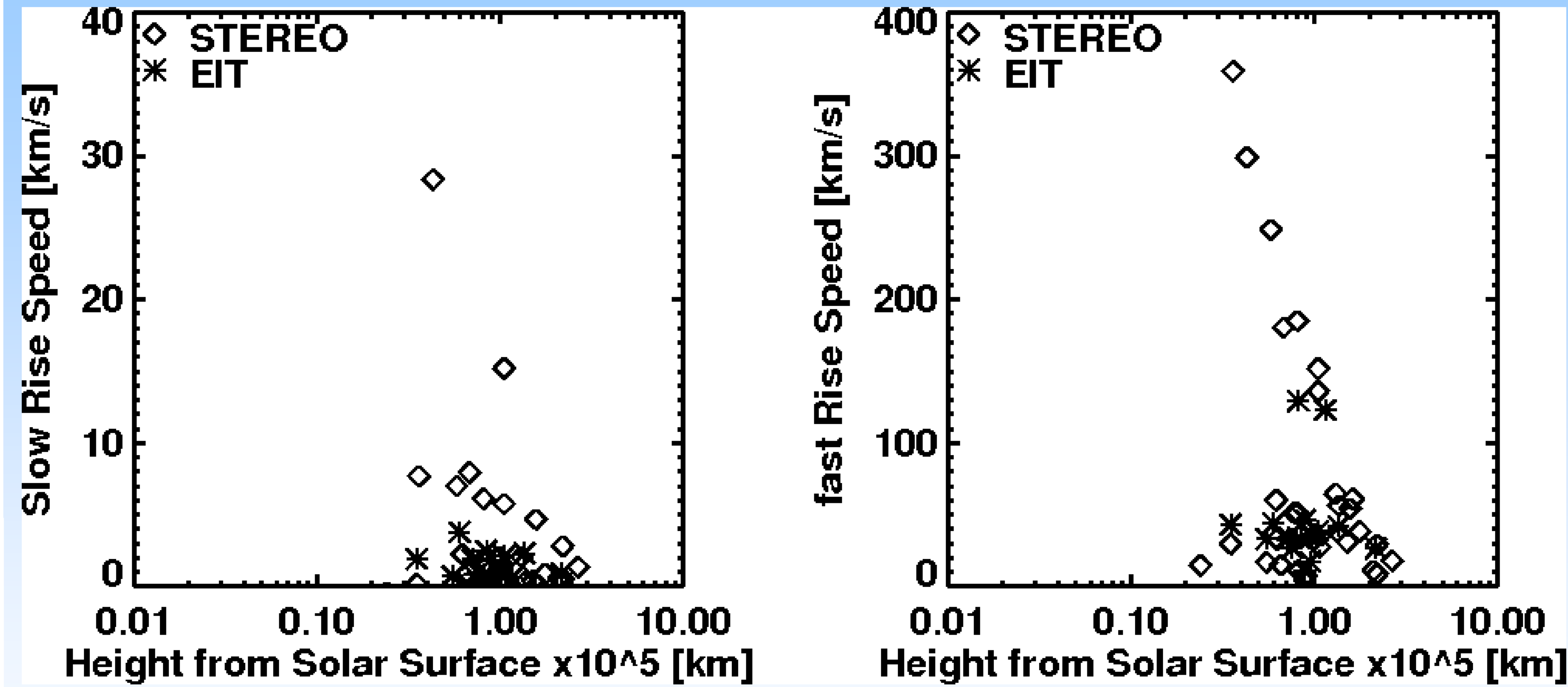
- Location of preflare brighting vs. TC.
- Potential-field flare?
- Twisting/distortion start with preflare brightening (cancelation/EF reconnection)?
- Looks like this, but is it correct (can it be verified)?:
  - Gradual flux cancelation.
  - Builds flux rope and leads to slow rise.
  - Bursts of aborted runaway reconnection result in slow-rise steps.
  - MHD instability and/or runaway TC --> fast eruption.
  - Collapsing envelope field --> main flare loops.
  - Eruption arrested in this case.

So, What’s Nice About L5?

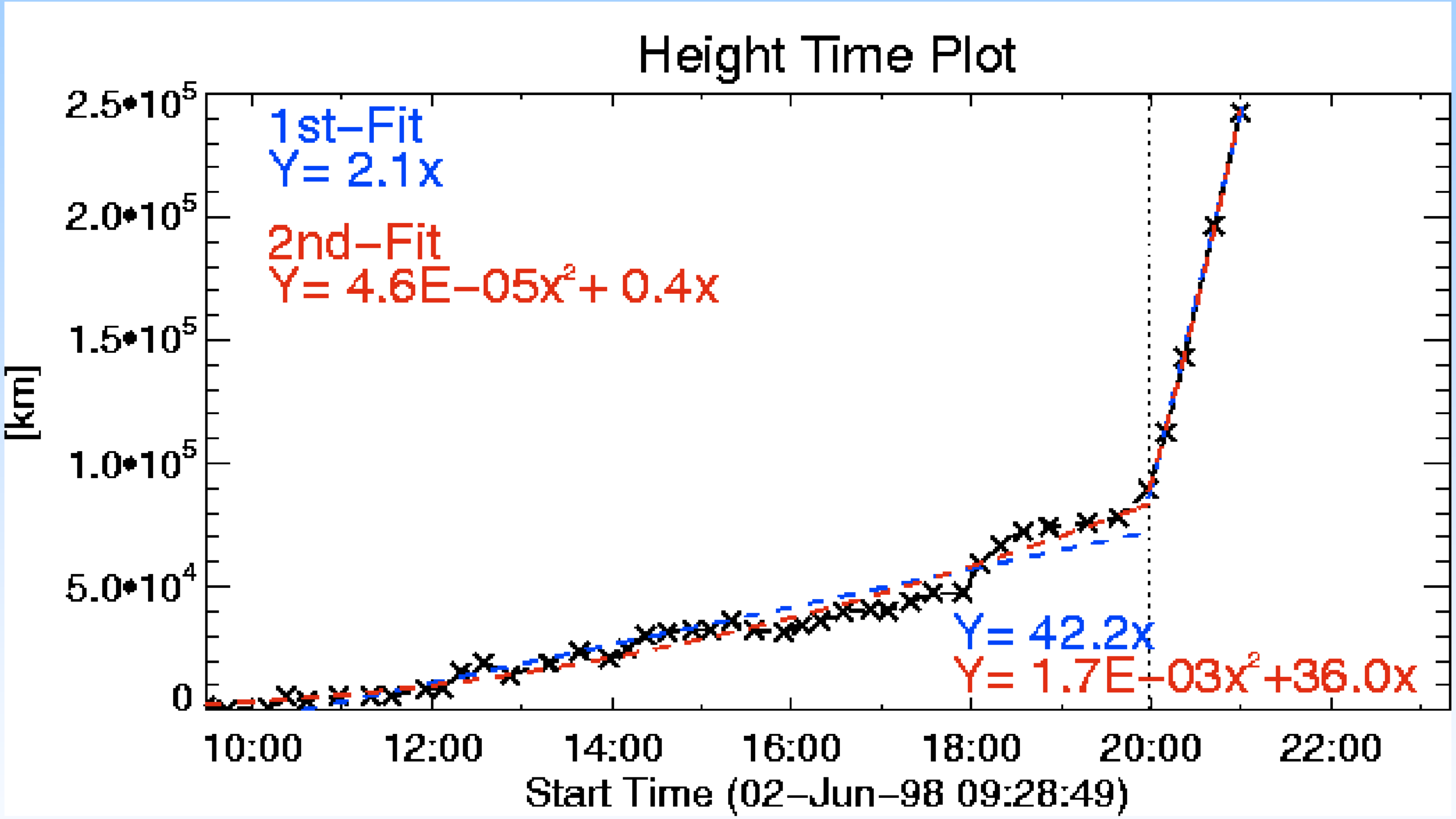
- View is from the East of Earth view.
- Can see filaments in profile near “halo position.”
- Can see magnetic configuration of ARs prior to halo position.

Filament Launch Heights

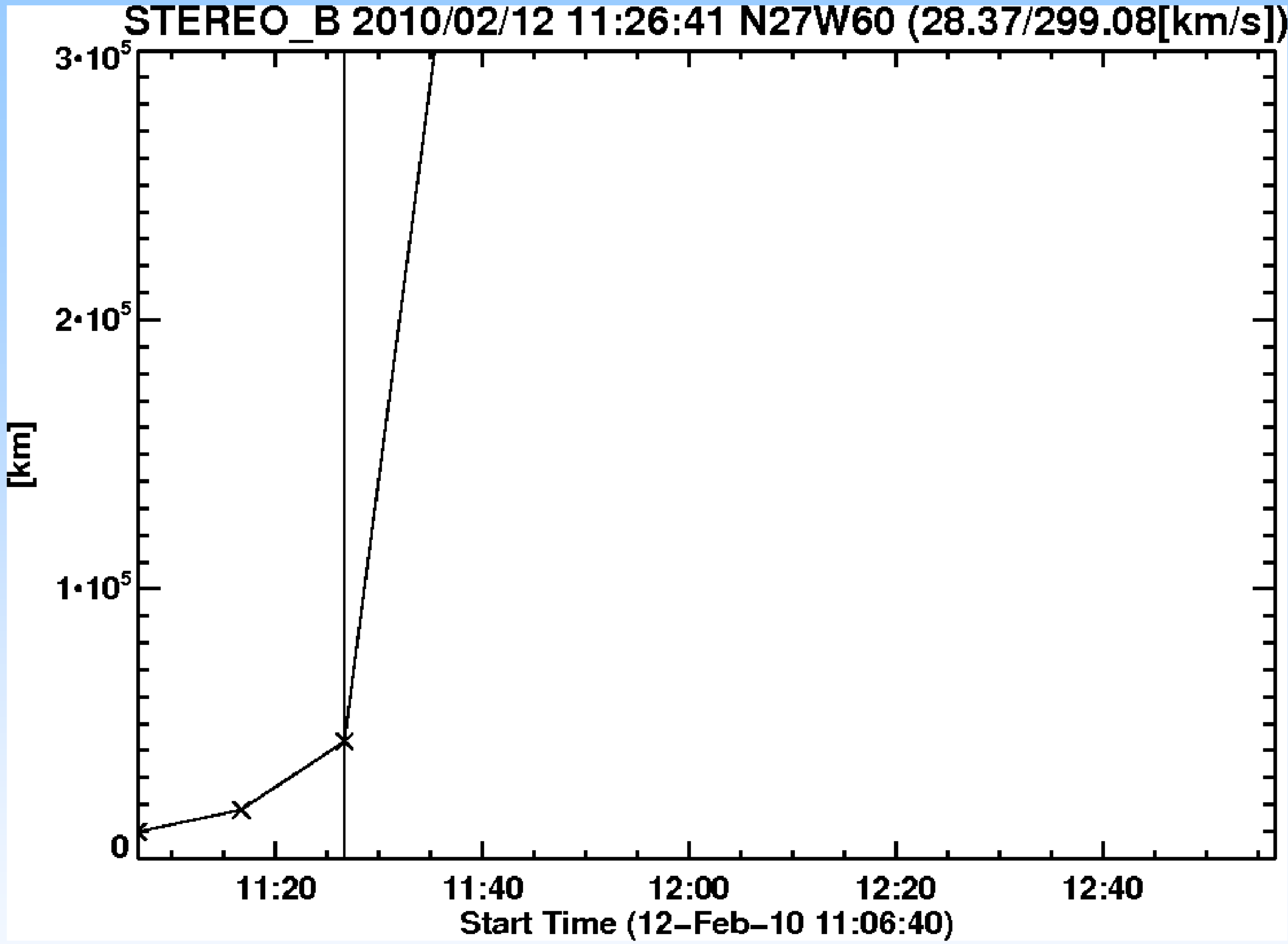
- With Sachiko Akiyama, N. Gopalswamy
- Use filament eruption data from EIT and STEREO (so far).
- Until now emphasis has been on slow quiet region eruptions.



Launch hts ~ $2x10^4$ km ~ $3x10^5$ km



EIT QS event; launch ht ~ 80K km.



STEREO M8 Event - Launch Ht ~ 40K km.

Conclusions for Filament Launch Heights:

- Virtually every filament that rises above 50K km will erupt within 48 hours (Zirin 1988). This is consistent with what we find.
- Critical eruption height theory discussed in terms of coronal B-gradient (Filippov & Den 2001).
- Cadence: Need ~ 1 min for AR filaments (TRACE); QS filaments could be ~10 min (EIT).
- Rise prior to eruption frequently occurs in steps, making extrapolation of eruption-onset time questionable.
- We are trying to relate eruption-onset height to various parameters (B, slow-rise velocity).
- A better understanding of these issues could help in predicting eruptions from L5.